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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Appl. No.	:	10/648,687
Applicants	:	Robert Sigurd Nelson, William Bert Nelson
Filing Date	:	August 25, 2003
Examiner	:	Christine Sung
Art Unit	:	2878
Title	:	DEVICE AND SYSTEM FOR ENHANCED SPECT, PET, AND COMPTON SCATTER IMAGING IN NUCLEAR MEDICINE

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

August 2, 2004

Dear Sirs:

Please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims. None.

Remarks/Arguments begin on page 4 of this paper.

Amendments to the Specification

Please add the following new paragraph preceding the paragraph beginning on line 16 on page 40:

There are a number of DOI techniques developed for face-on, high resolution PET using scintillators including readout from front and back ends of a scintillator crystal array (dual readout), "Phoswich", offset front and back crystal arrays, light sharing between adjacent crystal elements, pulse shape discrimination, etc.). One or more of these techniques can be employed in an edge-on DOI format to provide sub-aperture resolution for SPECT, PET, and Compton gamma cameras. Calibration will be necessary. The dual readout approach is attractive because edge-on DOI spatial resolution can be tuned for uniformity. A variety of photodetectors such as photomultiplier (PMT), flat PMTs, avalanche photodiode arrays (APDs), position sensitive APDs, HgI2 arrays, silicon drift detectors (SDDs), photodiode arrays, etc. can be used depending on space requirements and costs. Consider a specific example that might be used for high resolution, face-on PET imaging. Suppose that a face-on detector module that consists of a 30x30 array of 1x1x8 mm crystals (approximately 8 mm of stopping power using BGO, LSO, YAP, etc. scintillator material) uses a dual readout. The face-on detector surface resolution is 1 x 1 mm (ignoring reflective coating thickness). Suppose that the face-on DOI resolution is approximately 1 mm. Now turn the face-on array on its side (edge-on). The stopping power is now increased from 8 mm to 30 mm although the original detector surface area is now reduced from 30x30 mm to 30x8 mm. The edge-on detector depth resolution is fixed by the dimension of a crystal element at 1 mm. And the edge-on detector surface resolution is now 1 mm x the aperture resolution (determined electronically using the face-on DOI measurement technique to be 1 mm in this case). Now the 1 mm aperture resolution over 8 mm is now accomplished with 2 readout arrays rather than 8 edge-on readout arrays each coupled to a scintillator array with 1 mm aperture height. The total amount of lost space due to the thickness of the edge-on readout arrays is also reduced relative to the straightforward edge-on array implementation. Note that the dual readout approach will result in reduced energy resolution compared to the use of discrete edge-on detector arrays. Although the dual readout technique can be implemented with pairs of 1-D or 2-D photodetector arrays, it may be advantageous to use fewer readout elements. Position sensitive PDAs represent one possible solution. Another approach that could be cost-effective uses the idea of cross strip readouts used to create 2-D semiconductor detectors with only 2 sets of orthogonal strips. The same concept can be applied to a scintillator array by coupling linear photodetector arrays to both ends of the scintillator array with an orthogonal orientation. This cross strip scintillator array can be used with edge-on and face-on detector formats. Although a uniform rectangular cross section for the scintillator "straws" is straightforward to implement, non-uniform cross sections can be used. For example, a PET ring detector design could use a set of concentric scintillator rings that are segmented along the radial so that the elements have a wedge-like shape

when looking along the axis of the ring detector. In this case the edge-on aperture resolution would correspond to the axial resolution. Other forms of non-uniform cross sections can be employed if beneficial. For example the rows of scintillator elements in a 2-D array could be offset or shifted with respect to the adjacent rows so as to reduce patterns that could create spatial resolution artifacts. Another example is the manipulation of a parameter such as the scintillator material or cross section as a function of depth (see Nelson, U.S. Patent Number 4,560,882) and thus manipulate the response to incident radiation parameters such as the radiation type, energy, polarization, spin, etc. (radiation may include x-rays, gamma rays, charged particles, and neutral particles). Yet another example is to alter the scintillator material as a function of aperture position thereby allowing the use of either pulse-shape discrimination or signal distribution or both techniques together. Face-on Phoswich PET detectors with a back end readout use a similar concept to obtain DOI information by examining the pulse-shape distribution.

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Remarks/Arguments

In the specification the new paragraph on page 40 has been added in order to clarify that there are a number of known DOI readout techniques developed for face-on detectors. Additional detail is provided as to the advantage of the dual readout approach. Additional efficiencies may be gained (with respect to the number of readout elements needed) by using a cross strip technique to create 3-D arrays from 1-D or 2-D scintillator arrays. In addition, the cross sections of scintillator array elements need not be uniform in shape or in alignment to use the edge-on sub-aperture resolution technique based on DOI information.

If there are questions I can be contacted by email (rnelson@mail.sdsu.edu) or by phone (619-594-1013).

Respectfully submitted,

Robert Sigurd Nelson | August 10, 2004

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